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PATENT SPECIFICATION

1,073,605

DRAWINGS ATTACHED.

Inventor:—HAROLD EDWIN GEORGE ROWLEY.

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Int. Cl.:—B 29 d.

COMPLETE SPECIFICATION.

Improvements in and relating to Perforating Films of Thermoplastic Material.

We, T. J. SMITH & NEPHEW LIMITED, a British Company, of Neptune Street, Hull, Yorkshire, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to thin films which structurally have uniformly or otherwise closely spaced recesses on at least one surface, of any suitable thermoplastic material which is capable of being softened and melted by heat, and more particularly to methods for imparting to such films a desired pattern of perforations, even fine perforations, which extend through the thickness of the film; and also to the perforated film so produced.

The general method of perforating such a film according to the present invention is to hold it slightly stretched over and in contact with a cylindrically curved unbroken metal surface, with a desired arc of contact for the film, with one surface, preferably the or a recessed surface, of the said film in contact with the convex curved metal surface, and to subject the exposed surface of at least a portion of the film which is thus held, to the heat either of a flame or of a jet of heated gaseous fluid with or without moving the film in relation to the curved metal surface, the time of subjection to heat (which may be a small fraction of a second) and the temperature of the flame or jet being so chosen that only those portions of the thin film which constitute the base or bottom wall of each recess are melted.

The material of the film which comes under the action of the flame or jet and which constitutes the bottom wall or base of each recess of the film in this zone, will melt by this treatment provided that the various governing features are correctly chosen, and, by the relative movement of the flame or jet in relation to the film, the pattern of perforations through the film will conform generally to that of the recesses although their actual area may be somewhat less.

The desired temperature and time period can readily be found experimentally for any given material, thickness of material, and pattern of recesses in the film, as well as, in the case of utilising a flame, the particular combustible gas mixture for the flame (for instance, Town gas and air or an oxy acetylene mixture) or, in the case of a jet, the particular temperature and pressure for the gaseous fluid (which preferably is air). Temperatures of 1200°C, or even higher, can be utilised, for example that of normal flames.

Amongst other thermoplastic materials suitable for perforation by the method according to the invention but, of course, not limited thereto, may be mentioned polyethylene, polypropylene, polyvinyl chloride, polyester, polyamide and polystyrene.

Structurally, the films may have many forms and, by way of example but without limitation thereto, they may comprise a flat upper surface and an under surface which has the spaced recesses.

The upper surface need not be flat, but the film can be of uniform thickness and have pressed-out or cast recesses in one surface which, on the other surface, are convex projections. In other cases, one surface can be flat and the other surface formed with a diamond-like-pattern network of projecting portions which include recesses between them. Further, such a diamond-like or similar pattern may be formed on the two surfaces of the film; in the last instance, the depth of the recesses on one surface may be equal to the depth on the other surface or different.

Whatever the actual structure, the thin parts of the film which are to be fused by the flame or hot gaseous jet, has a preferred range of thicknesses which can be from, say, 0.00025 inches to 0.005 inches, or even more. In some cases, of course, the remaining part of the film has the same thickness, although in other cases this remaining part of the film, by its structural formation, of necessity has a greater thickness.

Although not limited thereto, the thickest part of the film can be, for example, from 0.002 inches up to, say, 0.100 inches.

In order that the invention may be better understood, it will now be described with reference to the accompanying diagrammatic drawings which are given by way of example only and in which:—

Fig. 1 is a greatly enlarged section of a thermoplastic film of uniform thickness having pressed-out or cast recesses therein, which shows one form of starting material for the process according to the present invention.

Fig. 2 is a similar view to Fig. 1 but showing the recesses on one surface of a film of non-uniform thickness.

Fig. 3 is an under plan of either Fig. 1 or Fig. 2.

Fig. 4 is a similar view to Fig. 2 but of another example of film with the recesses in one surface.

Fig. 5 is a view similar to Fig. 4 but with recesses in both surfaces of the film.

Fig. 6 is an under plan of either Fig. 4 or Fig. 5.

Fig. 7 is a diagrammatic perspective view of one particular method of carrying the invention into effect.

Fig. 8 shows a diagrammatic sectional elevation of a portion of the installation shown in Fig. 7 and to a different scale.

Fig. 9 is a very greatly enlarged diagrammatic vertical sectional elevation of a fragment of Fig. 8, and

Fig. 10 is a further sectional elevation of a film similar to that shown in Fig. 5, of a starting material to carry the process of the invention into effect.

The thermoplastic film in Fig. 1 is formed from a sheet 11 of uniform thickness with pressed-out or cast portions in uniform arrangement to leave circular recesses 12.

In Fig. 2, the film is formed from a sheet having two flat surfaces 13 and 14, with the uniformly arranged circular recesses 12 in the surface 14.

A portion of the film as seen from the underside of Figs. 1 and 2 is shown in Fig. 3.

In Fig. 4, recesses 15 are formed in one flat surface 16 of a film 17, which has a flat upper surface, and a corresponding film is shown in Fig. 5 but with recesses 18 and 19 in the upper and lower flat surfaces respectively, to leave thin portions 20 of the film constituting the bottom wall or base of each recess 18 or 19.

Fig. 6 shows a view from beneath of either Fig. 4 or Fig. 5, and from this Fig. 6 it can be seen that the recesses are of square or diamond shape. These can be regarded as being left in the surface by broad diagonally crossing strip portions of the same height on the said surface.

It should be pointed out that the thickness of the film shown in the drawings is greatly exaggerated to indicate the various changes of thickness. In many cases, however, the films would only be some 0.004 inches to 0.002 inches thick, or even less, at their thickest parts. Also, the relative spacing, size and disposition of the recesses is only shown to illustrate the "style" of the films.

The recesses and the spaces can be fine, for example there may be some 400 recesses to the square inch, and these have an approximate diameter of one-sixtyfourth of an inch. Larger recesses can be used at greater spacing to produce any required pattern of recesses where required.

The thinned parts of the film which ultimately are to be fused according to the method of the invention, for example the upper parts of the film bounding the recesses 12 in Fig. 1, or the thinned upper parts bounding the recesses 12 in Fig. 2, or the recesses 15 in Fig. 4, or the thinned parts 20 between the recesses 18 and 19 in Fig. 5, have any desired range of thickness, for example, say, 0.00025 inches to 0.005 inches, or even more.

The diagrammatic views Figs. 7, 8 and 9 illustrate a practical apparatus for carrying the invention into effect. It comprises a rotatable hollow metal cylinder 21 with an unbroken outer curved surface, as a carrier for the film 22, which film is held under slight tension in contact with the surface over a desired arc as shown. The film proceeds from a let-off roller 23 and passes to a take-up roller 24 via the said cylinder 21, and while the film is in contact with the surface of the rotating cylinder 21, in some cases, it does not move over the said surface, but with the said surface. In other cases, however, it can have relative movement with the surface of the cylinder. That is to say, the linear speed of the surface of the cylinder can be more or less than that of the film.

In an intermediate position of this contacting portion of the film 22 with the curved surface of the cylinder 21, the outer surface of the slightly stretched film passes in front of a row of flames 25 from a burner 26 of suitable construction. In some cases this burner could be replaced by a flattened jet or a row of jets for a heated gaseous fluid, which forms the heating means, and the spacing of the burner 26 for the flames 25 or of the nozzle for the jet or jets, from the surface of the film, may be adjustable.

In operation, when the linear speed of the cylinder surface and the film are the same, the film 22 and the hollow cylinder 21 turn as one for that portion of a revolution in which the film contacts the plain surface of the cylinder, and in an intermediate position of this portion the heat treatment from the flame 25 is applied. To prevent the cylinder 21 from being unduly heated, cooling means such as a circulating liquid coolant may be supplied to the interior thereof; an inlet pipe 27 and outlet pipe 28 for the purpose have been indicated in Fig. 7.

Fig. 8 shows the film (such as indicated in Fig. 4) arriving at the cylinder 21 and turning therewith through an angle of about 90°. It is in a stretched condition, and the air in the recesses 15 from where the film contacts the cylinder 21 up to the flaming zone, is held imprisoned in the recesses.

Fig. 9 shows a highly magnified view of the position of the heating zone where the surface of the portion of the cylinder 21 is shown as a vertical straight line. From this figure it will be appreciated that the portions 29 of the under surface of the film 22 which lie on the plain surface of the cylinder 21, when the heat treatment is being effected, rapidly transmit the heat therethrough to the metal of the cylinder 21, which is a good conductor, whereas the thinned portions 30 of the film which come above the recesses 15 in its underside, cannot transmit the heat directly to the cylinder, but only to the air imprisoned in the recesses, which air is a relatively poor conductor of heat, so that these thinned portions 30 of the film which do not contact with the plain surface of the cylinder 21 and which bound the recesses, are fused by the heat to form the perforations such as indicated at 31, Fig. 9; the action is assisted by the expansion of the air imprisoned in the recesses 15.

With continuous operation there will thus be produced a perforated film of standard width, having uniformly spaced fine perforations. The number of perforations per square inch, of course, will vary with the number of recesses it is a practical proposition to form in the particular film concerned. In practice, these may comprise a few hundreds up to 1000, or even more, uniformly spaced fine perforations per square inch.

Existing film may be processed to recess one or both surfaces so that this film can be given the perforating operation according to the invention. In other cases the film may be formed at the first portion of an apparatus, either with one or both surfaces recessed, and then this film passed immediately to the perforating zone of the apparatus. In still further cases, the film can be formed flat on both sides in the first zone of the apparatus, then passed to a second zone where it is given the necessary recesses in one or both surfaces, and finally it can pass to the perforating zone.

In a particular case, the film could have parallel or other spaced grooves on one surface and similarly or differently arranged grooves on the other surface, the depths of the grooves on both surfaces being equal or unequal, the total depth in any case being less than the total thickness of the film. The arrangement would be for the grooves of one surface to "cross" those of the other surface, to leave portions of the film of minimum thickness at the crossing points. These would constitute the pattern for the perforations, and these thinned portions would be fused to form the perforations in the method according to the present invention.

When the film to be perforated is of the nature shown in Fig. 5, either surface may be brought into contact with the surface of the cylinder 21. This also applies to the form of film shown in Fig. 10. In the last case, where the shallower recesses 32 come against the cylinder 21, then the outer, deeper recesses 33, whose "mouths" are open, to some extent will act as guides for the flame or hot gases to lead the heat to the thinned portions 34, to melt them and thus form the perforations.

According to a further feature of the present invention which can be regarded as a modification of or a corollary to the main feature, in some cases a film such as shown in Fig. 2 or Fig. 4, where the thin portion of the film at the base of the recesses is only a small or even a very small fraction of the total thickness of the film, can have the flat non-recessed surface in contact with the cylinder 21, so that the recesses such as 12 or 15 have open "mouths" (similar to those as set forth in regard to the form of film shown in Fig. 10) to lead the flame or hot gases to the relatively very thin portions bounding the ends of the recesses, so that these very thin portions will melt to form perforations before there is an appreciable melting of the thicker parts of the film.

In some cases the film may be subjected

to a uniaxial or to a biaxial stretching, so that the thin portions thereof are more susceptible to the heat treatment by flame or hot gaseous fluid.

The invention is not limited to the precise forms or details herein set forth, as these may be varied to suit particular requirements.

WHAT WE CLAIM IS: —

1. A method of perforating a thin film of a thermoplastic material capable of being softened and melted by heat in which the film is provided with spaced recesses in at least one surface thereof and in which the film is held in a slightly stretched condition over and in contact with an unbroken cylindrically curved metal surface with a desired arc of contact and the exposed surface of at least a portion of the film thus held is subjected to the heat of a flame or a jet of heated gaseous fluid with or without moving the film in relation to the curved metal surface, the time of subjection to heat (which may be a small fraction of a second) and the temperature of the flame or jet being so chosen that only those portions of the thin film which constitute the base or bottom wall of each recess are melted.

2. A method of perforating a thin film as claimed in claim 1, in which the unbroken cylindrically curved metal surface is the peripheral of a rotatable hollow metal cylinder with or over which the film to be perforated moves with the same or a different linear speed, through the zone heated by the flame or jet, the speed of travel of the film being such that the portions of the film forming the bases or bottoms of the recesses are melted to form the perforations whilst the other portions of the film remain unperforated.

3. A method of perforating a thin film as claimed in claim 1 or 2 in which the film material has recesses on both surfaces, to leave thinner portions of the film to be melted to form the perforations, between recesses on both surfaces, the recesses on one surface having the same depth as those on the other surface, or a different depth, and the recesses which come on the exterior serving as guides for the hot flame or jet to the thin film portions bounding the recesses.

4. A modification of the method of perforating a thin film as claimed in claim 1 or 2, in which the film is recessed on one surface only, to leave the thinner portions at the base of the recesses only a small fraction of the total thickness of the film, and in which the non-recessed surface is in contact with the unbroken curved cylindrical surface, whilst the recesses which come on the exterior serve as guides for the hot flame or jet to the said thin film portions bounding the recesses, to melt said portions to form the perforations.

5. A method as claimed in any preceding claim in which the film has thinner portions at the bases or bottoms of said recesses and the film is uniaxially or biaxially stretched to render said thinner portions more susceptible to heat treatment.

6. Films of thermoplastic material having spaced recesses on one or both surfaces, when perforated by any of the methods claimed in the preceding claims.

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1073605 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1.

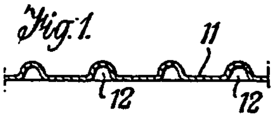

Fig.4.

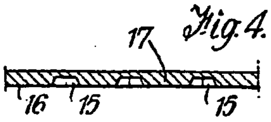

Fig.2.

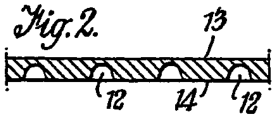

Fig.5.

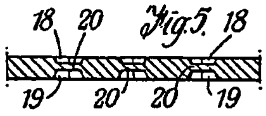

Fig.3.

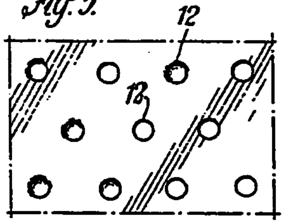

Fig.6.

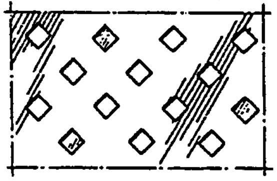

Fig.9

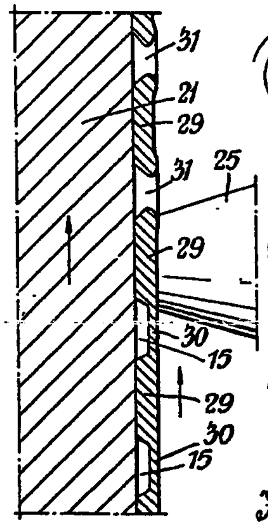

Fig.7.

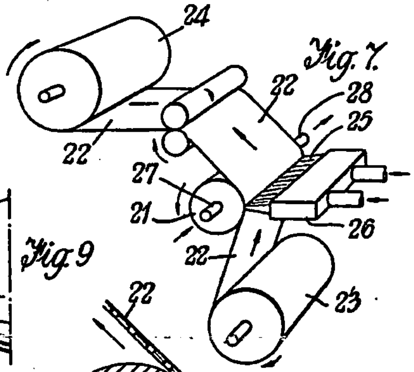

Fig.8.

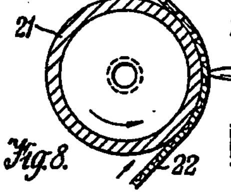

Fig.10.